Comparison of the Effectiveness of a Personal Computer Aviation Training Device, a Flight Training Device, and an Airplane in Conducting Instrument Proficiency Checks

Semi - Annual Report

April 2, 2004

From September 21, 2003 to March 20, 2004

Henry L. Taylor, Donald A. Talleur,
Esa M. Rantanen, and Tom W. Emanuel, Jr.

FAA Cooperative Agreement 2001-G-037

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report covers the fifth six months of a three-year effort to compare the effectiveness of a personal computer-based aviation training device (PCATD), a flight training device (FTD), and an airplane for conducting instrument proficiency checks (IPC). During the six-month period covered by the report, we have:

- Started, as of March 20, 2004, ninety- one subjects, an increase of nine.
- Completed a total of 468 sessions, an increase of 64 sessions. Of these 468 sessions 245 have been familiarization sessions (80 airplane, 82 PCATD and 83 FTD).
- Completed a total of 75 IPC#1 sessions and 75 IPC#2 sessions; an increase of 13 IPC#1 and 16 IPC#2 sessions respectively. The subject completes the study after IPC#2; thus 75 subjects, the required number to in the experimental design have completed the study.
- Presented a paper, C*omparison of the Effectiveness of a PCATDs, FTDs, and Aircraft Conducting Instrument Proficiency Checks*, at the Research Roundtable, University Aviation Association Fall Education Conference, October 24,2003, Dayton, OH.
- Presented a paper**,** *The Effectiveness of a Personal Computer (PCATD), an Aviation Training Device (FTD), and an Airplane in Conducting Instrument Proficiency Checks,* at the Technology Enhancements for Aviation Classrooms Seminar, University Aviation Association Fall Education Conference, October 22,2003, Dayton, OH.
- An abstract, *The Effectiveness of Personal Computers (PCATDs) and Flight Training Devices (FTDs) on Instrument Training for Pilots,* has been accepted for presentation at the Aerospace Medical Association 75th Annual Scientific Program Meeting, May 2004.

Our research project has met all projected milestones. We have completed the remaining 16 required subjects in the experiment during these six months; we completed 16. During the next 6 months we plan to complete the analysis of the data and write the final report. We will also complete the development of procedures to interpret and score the information collected through the in-flight airplane performance measurement system as well as the performance systems for the PCATD and FTD.

INTRODUCTION

The specific goal of the project is to compare the performance of an Instrument Proficiency Check performed in a PCATD, a FTD, and an airplane (IPC #1) with a second IPC in an airplane (IPC #2). Currently, the PCATD is not approved to administer

IPCs. The comparison of performance in a PCATD to that in an airplane will investigate the effectiveness of the PCATD as a device in which to administer an IPC. The comparison of performance in a Frasca and the airplane will determine whether the current rule to permit IPCs in a FTD is warranted. Finally, the comparison of performance of pilots receiving IPC #1 in an airplane with one Certified Flight Instructor, Instruments (CFII) and IPC #2 in an airplane with a second CFII will permit the determination of the reliability of IPCs conducted in an airplane.

REQUIREMENTS FOR THE EXPERIMENT

We will use the framework of the four essential elements for the study: the experimental team, subjects, equipment, and procedures, to describe our progress to date.

Experimental Team

Henry L. Taylor, Tom W. Emanuel, Jr., Esa M. Rantanen and Donald A. Talleur serve as co-principal investigators on this project. The experimental team continues to meet once each week by conference call. An agenda is prepared and circulated in advanced and minutes of the meeting are prepared and circulated. Under the agreement of the cooperative agreement the COTR is furnished with the agenda and minutes. The experimental team met at the Institute of Aviation September 5, 2002.

Subjects

A total of 75 subjects were used (25 subjects in each group; FTD, PCATD and airplane). This represents a change from the original proposal as discussed in the last six months report. The original proposal called for 105 subjects with 25 per group. Due to funding short falls the number of subjects were reduced. As of the last report we had had 204 potential subjects in the potential subject pool. The number of subjects in the subject pool has not changed but we will no longer use subjects in the potential pool who are more than 2 years out of currency and require training. As a result our current subjects fall into one of three categories of instrument currency: 1) instrument current; 2) within one year of currency; and 3) outside of one year of currency but within two years of currency.

Equipment

The equipment has worked satisfactory during the 6-month period.

Procedures

All subjects have participated in a VFR familiarization flight in each of the following: FTD, PCATD and airplane. The subjects also receive a review of the aircraft systems and instrumentation in each device. Following the familiarization session, all subjects are assigned to one of three groups and have received a baseline IPC flight in the FTD, PCATD and airplane (IPC#1) according to which group they are assigned. IPC#1 is

flown with a CFII who acts both as a flight instructor and as an experimental observer. The initial IPC (IPC#1) is used to collect baseline data and to establish the initial level of proficiency for each subject who participants in the project. Following this the subject is given the second IPC (IPC# 2).

Objective Performance Measures

Objective pilot performance assessment in the present project will be done through several measures derived from the data furnished by the flight data recorders (FDRs) on board the aircraft used for the Instrument Proficiency Check (IPC) flights as well as the data outputs from the Elite Personal Computer Aviation Devices (PCATDs) and Frasca Flight Training Devices (FTDs). In the previous study (Rantanen & Talleur, 2001; Taylor et al., 2001) we used five measures that were derived from the FDR data for a number of flight parameters: (1) standard deviations, (2) root mean square error, (3) number of tolerance exceeded, (4) cumulative time tolerance was exceeded, and (5) mean time to exceed tolerance given the momentary trend at a time of observation. These measures will be used in the present study as well. However, we will also investigate the use of time series analysis methods to detect more fine-grained features in the data than was possible with the above-mentioned metrics. In particular, we will investigate the use of:

- correlation functions, to distinguish pilot-induced effects from noise in the data,
- linear regression models to investigate linear trends in the data, and
- spectral density functions and Fourier approximations to identify periodicity in the data.

No additional milestones have been reached since the last report. We have just appointed a graduate research assistant to assist with is part of the study.

RESULTS TO DATE

As of March 20, 2004 a total of 91 subjects had started the study. A total of 468 subjects have completed all types of sessions. The following table shows the sessions completed as of 3/20/2004.

Sessions Run:	Totals
Air-fam*	80
PCATD-fam*	82
Frasca-fam*	83
IPC#1	75
IPC#2	75
P-Training	27
F-Training	45
A-Training	1
All types:	468

# of Subjects Started	91

Total completed:75

In terms of sessions completed, there have been 245 familiarization (fam) flights, (80 airplane fam flights, 82 PCATD fam flights and 83 Frasca fam flights. Seventy-five subjects have completed the IPC # 1 flight, and 75 subjects have completed the IPC #2 flight.

An analysis of the data collected as of 3/20/2004 is shown in the following three tables.

Table 1 shows the pass/ fail numbers and percentages for the three groups for IPC #1 and IPC #2 for the pilots who have completed IPC1 and 2 respectively. There is a clear trend which indicates that all groups perform better on IPC #2 than on IPC #1. For the Aircraft Group this is most likely due to the effect of learning from the experience of IPC#1. This also may be the best explanation for the Frasca and the PCATD Groups.

Table 1. *Pass/Fail for IPC#1 and IPC#2 for the Three Groups*

		IPC#1					IPC#2			
Group	N	Pass	%	Fail	%	N	Pass	%	Fail	%
Aircraft	***25***	6	24%	19	76%	***25***	13	52%	12	48%
FTD	***25***	9	36%	16	64%	***25***	14	56%	11	44%
PCATD	***25***	9	36%	16	64%	***25***	15	60%	10	40%

Table 2 shows the pass/fail Ns and percentages for IPC 1 and 2 by currency status. Of the 53 pilots who were current, only 19 (36%) passed IPC#1. In the study by Taylor, Talleur, Bradshaw, Emanuel, Rantanen, Hulin, and Lendrum (2001) 45 instrument current pilots out of 106 (42%) passed IPC #1.

Table 2. *Pass/Fail for IPC#1 and IPC#2 by Currency Status*

		IPC#1					IPC#2			
Currency	N	Pass	%	Fail	%	N	Pass	%	Fail	%
Current	***53***	19	36%	34	64%	***53***	30	57%	23	43%
Within 1 year	***7***	2	29%	5	71%	***7***	6	86%	1	14
Within 1-2 years	***1***	1	100%	0	0%	***1***	1	100%	0	0%
2-5 years (Frasca)	***8***	1	13%	7	87%	***8***	1	13%	7	87%
2-5 years (PCATD)	***6***	1	17%	5	83%	***6***	4	67%	2	33%

Table 3 shows the Pass/Fail rate for IPC# 1 and IPC# 2. Fourteen of the pilots who passed IPC#1 also passed IPC#2, but 10 of the pilots who passed IPC#1 failed IPC# 2. Twenty-eight of the pilots who failed IPC# 1 passed IPC# 2, but 23 of those who failed IPC# 1 also failed IPC#2. A total of 24 pilots passed IPC#1 (32%), and 42 pilots passed IPC #2 (56 %).

\Table 3. *Pass/Fail for IPC#1 and IPC#2*

		IPC#2 Pass	IPC#2 Fail	Total
	Pass	14	10	24
IPC#1	Fail	28	23	51
	Total	42	33	

PROJECT MILESTONES

The project milestones are based on a start date of September 20,2001and the revised schedule based on the funding reduction for year 3 and 4.

Task	Date	Completed
Identify Subject Pool	FY 2002, Q1	X
Complete equipment modifications	FY 2002, Q1	X
Complete Check Pilot Standardization	FY 2002, Q2	X
Begin Experimental Testing	FY 2002, Q2	X
Interim six-month report	FY 2002, Q2	X
Interim six-month report	FY 2002, Q4	X
Interim six-month report	FY 2003, Q2	X
Interim six-month report	FY 2003, Q4	X
Complete experimental testing	FY 2004, Q2	X
Interim six-month report	FY 2004, Q2	X
Prepare data file	FY 2004, Q3	
Complete analyses	FY 2004, Q3	
Final Report	FY 2004, Q4	

PROBLEMS AND SOLUTIONS

Hardware and Software

There were no hardware or software problems associated with the PCATDs or the Frascas, during the past 6 months.

Financial

The project has received a total of $401,990 for a period through September 30,2003. The first increment of $68,383 was received September 20,2001, the second increment of $234,166 was received 2/25/02 and the third increment of $99,44 was received. The third increment was part of the budget revision discussed in the last 6-month report. Due to lack of funds a revised budget and a revised proposal was submitted as follows: for FY 2003, from February 26,2003 through September 30,2003, $99,440 , and $65,775 for FY 2004 from May 22,2004 thru September 30,2004 for a total of $165,215. (A no cost extension was granted to May 22, 2004)This represents a budget reduction of $293,848. The FY 03 increment has been received and we need the FY 04 increment of $65,775 to complete the project.

Subjects

In the last report we indicated that we had completed a total of 62 IPC#1 sessions and 59 IPC#2 sessions; an increase of 15 IPC#1 and 16 IPC#2 sessions respectively. The subject completes the study after IPC#2; thus 59 subjects have completed the study. As we reported in the last three reports, it has taken longer to complete the three-familiarization sessions than expected. Once the fam sessions have been completed we have had good success in getting the IPC#1 and #2 sessions scheduled and completed. During the past six months, we have completed the 75 subjects required in the study

PLANNING FOR THE NEXT SIX MONTHS

We plan to complete data analysis and write the final report during the next six months. We will also complete the performance measurement functions.

SUMMARY

The project continued smoothly during the third 6 months. We have completed experimental testing of the 75 required subjects.

REFERENCES

Box, G. E. P., & Jenkins, G. M. (1976). *Time Series Analysis: Forecasting and Control.* Revised Edition. Holden Day

Chatfield, C. (1975). *The analysis of time series: theory and practice*. New York: Wiley,

Cryer, J. D. (1986). *Time Series Analysis.* Duxbury Press.

Gottman, J. M. (1981). *Time Series Analysis: A Comprehensive Introduction for Social Scientists.* Cambridge University Press.

Lendrum, L., Taylor, H. L. Talleur, D. A. and Emanuel, T. W., Jr. (2003). *IPC data logger (A flight data recorder): Operation Manual Change 2*(AHFD-03-8/FAA-03-2). Savoy,IL:University of Illinois, Aviation Human Factors Division.

Rantanen, E. M., & Talleur, D. A. (2001). Measurement of pilot performance during instrument flight using flight data recorders. *International Journal of Aviation Research and Development, 1*(2), 89-102.

Taylor, H. L., Talleur, D. A., Bradshaw, G. L., Emanuel, T. W., Jr., Rantanen, E. M., Hulin, C. L., & Lendrum, L. (2001). *Effectiveness of personal computers to meet recency of experience requirements* (ARL-01-6/FAA-01-1). Savoy, IL: University of Illinois, Aviation Research Lab.

Vandaele, W. (1983). *Applied Time Series and Box-Jenkins Models.* New York: Academic Press.